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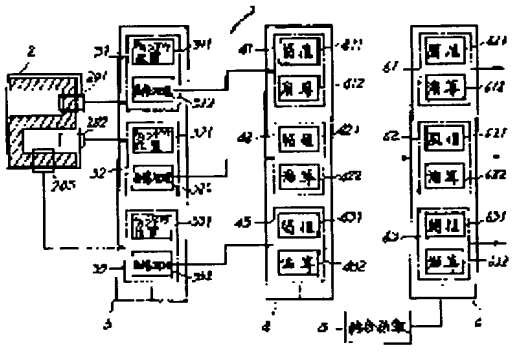
(54) CHARACTER RECOGNIZING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To recognize with high accuracy even if contrast is bad by extracting a level of the existence of a character line in a set window area from the brightness value of the window area or its differential value as continuous quantity.
SOLUTION: A character '2' is inputted to an image memory 2, window positions are stored in window position data storing parts 311, 321, etc., of each input unit and also the class of image processing is designated. Thereby, when differentiation from the rightside is designated as the class of image processing to an image in a window area 201, an input unit 31 performs the differential processing and outputs a result. Similarly, when the differentiation from the right side is designated as the class of image processing to an image in a window area 202, an input unit 32 performs the differential processing and outputs a result. And, a level of the existence of a character line in a set window area is extracted from the brightness value of the window area or its differential value as continuous quantity and character recognition is performed.



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CLAIMS

[Claim(s)]

[Claim 1] Character recognition equipment characterized by constituting so that character recognition can be carried out in the image processing of the window area set up to the character picture by extracting the level of the existence of the character line in the set-up window area as the value of the luminosity of a window area, or an amount of continuation from the differential value.

[Claim 2] Character recognition equipment according to claim 1 characterized by being constituted so that it may have the differential, the differential from the left, the differential from the upper part, the differential from a lower part, and the concentration sum total from the right as a kind of image processing in the aforementioned window area and these kinds can be specified to be the interactive modes.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the recognition equipment of the suitable character for recognition of the character in which character recognition equipments which used the image processing, such as a seal, printing, and a stamp character, are started, especially the contrast of a character and a background produces change in a quality of printed character bad.

[0002]

[Description of the Prior Art] Conventional character recognition equipment divides a character pattern into plurality like the publication to JP,61-255488,A, and depends it on

application of the method of superposition of carrying out comparison collating of the degree of similar for every division unit of the, and performing a recognition judging. It is the recognition algorithm with which this method used the binary picture, and in producing change, such as a piece and a blur, on a character line, in order to absorb this change with an algorithm, processing becomes complicated and the recognition time also increases. When the quality of printed character of a character changes, it becomes impossible for example, for a binary-ized threshold to also correspond in a fixed threshold. Moreover, although these recognition algorithms were performed by classifying the extracted feature according to a judgment tree, how to combine this feature for obtaining the optimal judgment was performed by trial and error by the experiment.

[0003]

[Problem(s) to be Solved by the Invention] Although the above-mentioned conventional technology is based on application of the method of superposition and a good result is obtained by character recognition, such as good paper of a quality of printed character, for the recognition algorithm using the binary picture, if the contrast of a character to recognize carries out binary-ization bad, when producing a piece and a blur, distinction is difficult, and the recognition algorithm had the problem that where of an incorrect recognition rate becomes high while it became complicated and the recognition time increased.

[0004] It is in the purpose of this invention offering the character recognition equipment which contrast is bad stabilized to what produces change to printing concentration like the character printed by industrial parts, and can recognize in a high precision, and can be automatically adapted also to change of a font.

[0005]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention constitutes the level of the existence of the character line in the set-up window area in the image processing of the window area set up to the character picture so that character recognition can be carried out by extracting as the value of the luminosity of a window area, or an amount of continuation from the differential value.

[0006] Moreover, it has the differential, the differential from the left, the differential from the upper part, the differential from a lower part, and the concentration sum total from the right as a kind of image processing in the aforementioned window area, it is constituted so that these kinds can be specified to be the interactive modes, and it is a thing.

[0007]

[Function] By using two kinds of edge information detected in two or more windows of each prepared suitable for a character field as a feature of a character from the differential picture of not only the luminosity information on a character line but a subject-copy image, the feature extraction stabilized with high reliability also to the bad printing character of contrast becomes possible.

[0008] In addition, as for the above-mentioned character recognition equipment, it is desirable to establish the mechanism in which how to attach the weight of many features for the feature extraction of a character in order to optimize the combination between the deed features with a sufficient precision can be automatically adjusted from an actual sample character. Moreover, it also becomes possible by carrying out the automatic regulation of how combining the feature using a sample picture actual as a method of determining to perform stable recognition.

[0009]

[Example] Drawing 24 explains the example of this invention from drawing 1 below.

[0010] Drawing 1 is one block diagram of the character distinction section showing one example of the character recognition equipment by this invention. In drawing 1 , the character picture for recognition is incorporated by the image memory 2 of the character distinction section 1 by TV camera 23 (drawing 2). To the window position data storage sections 311, 321, and 331 which store window position data in each input units 31, 32, and 33 and every ·· at the input unit group 3, ··, each window areas [there are the image-processing sections 312, 322 and 323 and ··, and] 201, 202, and 203 on an image memory 2 and ··, in an image processing, a deed processing result is outputted and the value of this processing result is sent to the middle unit group 4. There are the middle unit operation part 412, 422, and 432 and ·· with each middle units 41, 42, and 43 of the middle unit group 4, the threshold storing sections 411, 421, and 431 which store a threshold in ··, and ··, it calculates to the value which added the threshold to the output value from each input unit, and the result of an operation is outputted. The coupling coefficient by which the output value of each unit of this middle unit group 4 is stored in the coupling-coefficient storing section 5 is applied, and the value is sent to the output-unit group 6. There are the output units 61, 62, and 63 corresponding to the kind of character and ·· in the output-unit group 6, there are the output-unit operation part 612, 622, and 632 and ·· with the output threshold storing sections 611, 621, and 631 and ·· which store a threshold in each output unit, it calculates to the value which added the threshold to total of the value which lasted the coupling coefficient to the output value from each middle unit, and the result of an operation is outputted.

[0011] Drawing 2 is the hardware block diagram of the character recognition equipment of drawing 1 . The picture I/O circuit 13 which performs the output to a monitor TV 12 while character recognition equipment 10 inputs the signal from TV camera 23 and storing in an image memory 2 in drawing 2 , The general-purpose I/O circuit 14 for outputting and inputting an external signal with equipments other than character recognition equipments, such as a workstation The program data memory 15 which stores a program and data, It consists of an IC card interface 18 for connecting with the image processing processor 16 which performs an image processing, and IC card 17 used for preservation of various data, a teaching box 19 for manual operation, such as teaching, and CPU20 that controls the

above-mentioned whole operation. The character distinction section 1 (drawing 1) is realized here by the image memory 2, the program data memory 15, the image processing processor 16, and CPU20. That is, the window position data storage section 311,321,331 of an input unit, the threshold storing section 411,421,431 of a middle unit, the coupling-coefficient storing section 5, and the output threshold storing section 311,621,631 of an output unit are in the program data memory 15. The image-processing section 312,322,332 is realized by the image processing processor 16 and CPU20, and the middle unit operation part 412,422,432 and output-unit operation part 612,622,632 are realized by CPU20.

[0012] The procedure in which the character distinction section 1 next distinguishes a character is explained. Drawing 1 shows the case where the character "2" is inputted into the image memory 2, and the window position is stored in the window position data storage section 311,321 of each input unit, and the kind of image processing is also specified. Therefore, if the differential from the right is specified as a kind of image processing to the picture in a window area 301, the input unit 31 will perform the differential processing, and will output a result. Similarly, if the differential from the method of the right is specified as a kind of image processing to the picture in a window area 202, the input unit 32 will perform the differential processing, and will output a result. As a kind of this image processing, there are differential, differential from a left, differential from the upper part, differential from a lower part, the concentration sum total, etc. from the method of the right. In the case of the differential from a left, the method of this processing becomes like drawing 3 .

[0013] Drawing 3 (a), (b), and (c) are explanatory drawings showing the example of the differential processing from lefts, such as the image-processing section 312 of the input unit of drawing 1 . Drawing 3 (a) is the example of the window cut on the lengthwise character line, and a slash portion expresses a character line in this drawing. Drawing 3 (b) expresses the differential value about a line which * mark of the x directions of [when differentiating from a left] attached in the x directions in this window now. Drawing 3 (c) asks for total of this differential value "1", "2", "3", and "4", and is the output value of an input unit. As shown in this drawing 3 (c), the value which applied the differential value in the differential direction in this way in the window is calculated for every Rhine, and the average is considered as the output of the window. Moreover, about the window of the concentration sum total, the kind of image processing totals the concentration of all the pixels in a window, divides it by the number of pixels, and considers this average as the output of a window in quest of an average. Moreover, in the image processing in a window area, the output value of the input unit independent of the size of a window can be obtained by normalizing the value of an image-processing result in the size of a window.

[0014] The output value of these input units 31, 32, and 33 is respectively stored in one middle units 41, 42, and 43, and the middle unit asks for the output y which receives with

the sigmoid function of the following formula by the middle unit operation part 412,422,432 from the value z which added the threshold stored in the output value of this input unit at the threshold storing section 411,421,431. However, T is a constant.

[0015]

$y=1/(1+e^{-z/T})$ (1)

To the output value of each of these middle units 41, 42, and 43, the coupling coefficient is stored in the coupling-coefficient storing section 5 for every [each output units 61 and 62 and] 63. Each output unit totals the value which multiplied the middle unit output values y1 and j of the following formula (2) by coupling coefficients w1, k, and j. It asks for the output ok to which the output implement of the following formula (3) is also given to these values z2 and k by well function to the value x which added the output threshold stored in the output threshold storing section 611,621,631 by the output-unit operation part 612,622,623. However, T0 is a constant.

[0016]

[Equation 1]

数 1

$$z2,\ k=\sum_{j=1}^{2n} w1,\ k,\ j \times y1,\ j \qquad (2)$$

[0017]

$ok=1/(1+e^{-z/T0})$ (3)

Each output unit exists corresponding to the kind of character, and makes a distinction result the character corresponding to the output unit which took the greatest output value.

[0018] Next, a means to adjust the threshold of the middle units 41, 42, and 43 and output units 61, 62, and 63 and the coupling coefficient of the coupling-coefficient storing section 5 using the recognition result of a character is explained. Drawing 4 is explanatory drawing showing the procedure which the threshold of the middle unit of drawing 1 and an output unit and a coupling coefficient adjust. The output value of the reversal middle unit in drawing 4 is calculated by the formula (6). As shown in drawing 4 , by giving a teacher signal to each output unit, respectively, adjustment of a threshold and a coupling coefficient corrects the coupling coefficients w1, k, and j between the middle unit of the middle unit group 4, and the output unit of the output-unit group 6, and, next, corrects the thresholds w0 and j between the input unit of the input unit group 3, and the middle unit of the middle unit group 4. A teacher signal is the maximum of the output of each output unit, gives 1 to the output unit corresponding to the character of a correct answer, and gives 0 to other output units. Drawing 4 shows the example in the case of adjusting a threshold and a coupling coefficient about a number 2. Since a correct answer is a number 2, a teacher signal gives 1 to the output unit corresponding to a number 2, and it gives 0 to other output

units. This correction can search for the difference of each output unit and a corresponding teacher signal, and can be performed by the method learned as a back-propagation method as shown in adjustment signal **w0, j and **w1, and the following formula that generates k and j. However, Bk and Ck are constants.

[0019]

**w1, k, y1, j (4) [j=Bk-(tk-ok) -f' (z2, k),]

**w0, j=Ck-W1, j, and k(tk-ok) -f(z2, k) -f' (z1, j) (5)

In the threshold of the above-mentioned middle unit and an output unit, and adjustment of a coupling coefficient, it is dependent on whether the number of times of trial required for adjustment has the initial value of a coupling coefficient close to an adjustment result. A user can judge the initial value of this coupling coefficient, and this character recognition equipment 10 can be set up. Drawing 5 is explanatory drawing showing the screen where a user judges and sets up the initial value of the coupling coefficient of drawing 4 . This is surface drawing which has the kind of character, and the kind of input unit in all directions. In this surface drawing, a user sets up O, when a character line is in the window area of each input unit for every character, and when there is nothing, he sets up x. When the existence of a character line does not clarify, neither O nor x is set up. If a user performs such a setup, character recognition equipment 10 will carry out initial setting of that by which neither O nor x was set as "-1" in what was specified to be x by "+1" in the coupling coefficient of the middle unit connected to the output unit and input unit corresponding to the character specified to be O as initial value of a coupling coefficient to "0", respectively. If it does in this way, the number of times of trial of adjustment can be reduced from the case where a coupling coefficient is decided at random.

[0020] Next, how to set up the position and size of a window area 201,202,203 of the input units 31, 32, and 33 is explained. The position of a window area assumes a character field and expresses it on the basis of the zero of the outer frame. For this reason, the outer frame of a character is specified first and, next, a window area is specified. The outer frame and each window area of a character are numbered, this number is specified, and a setup is started. Drawing 6 is explanatory drawing showing the screen which sets up the position and size of a window area of drawing 1 . [of an input unit] Moreover, drawing 7 is the plan showing the example of the keyboard 11 used for operation of drawing 6 . The number of the outer frame of a character is decided to be "0" here, and the number of each window area is attached to 1, --9, A, --Z. A window area can be set up on this screen, looking at the character which it is going to register since a raw picture is always displayed. Since the number train is located in a line with the bottom of a screen, number specification of a window area moves cursor to the place of a number which it is going to specify by the right-and-left cursor key of a keyboard 11, and is performed by pushing the SET key. The outer frame of the introduction character is set up. Since movement of a character outer frame is movable vertically and horizontally with a cursor key here where a character outer

frame, i.e., "0" watch, is chosen, the position of a character outer frame is set up according to a suitable position. A setup of a window area is performed by choosing the number of a window area with cursor in this state. Moreover, since a crosshair cursor is displayed where a character outer frame is chosen when setting up and changing the size of a character outer frame, the point at the upper left of a character outer frame is set up first, and, next, a lower right point is decided. Since the value expressed with the coordinate made into a zero is displayed [upper left / of a character outer frame] in X of cursor, and Y position while moving the point at the lower right of a character outer frame here, precise positioning is possible. Next, a setup of each window area specifies and begins the number of a window area. A setup of the place of this window area specifies a position, moving cursor by the cursor key, since cursor is displayed on a screen. Since the value expressed with the coordinate made into a zero is displayed [upper left / of a character outer frame] in X of cursor, and Y position at this time, precise positioning is possible. Since a window area can be expressed with the four side type of parallel, specification of a position specifies three points in order of the upper left, the lower left, and the lower right. 1 set of sides of this parallel 4-side type must be horizontal or vertical. If this condition is not suited, it will be in the state of becoming an error and specifying a window area again.

[0021] If the above-mentioned position and above-mentioned size of a window area are set up, the kind of image processing which the image-processing section 312,322,332 of an input unit next performs in a window area 201,202,203 will be set up. Drawing 8 is explanatory drawing showing the screen which sets up the kind of image processing of the image-processing section of drawing 1 . This setup is performed by choosing the kind of image processing in a menu screen as shown in drawing 8 . In this example, five kinds, the differential from the left of a lengthwise character line, the differential from the method of the right, the differential from the upper part of a lateral character line, the differential from a lower part, and the whole concentration sum total, can be chosen. This selection result is stored in the image-processing section 312,322,332 of the input units 31, 32, and 33, and the image processing chosen at the time of character recognition is performed. Differential processing here comes out effectively, when the luminosity of a picture is not uniform, or when contrast is bad.

[0022] Drawing 9 (a) and (b) explain luminosity amendment of a picture below. Drawing 9 (a) and (b) are explanatory drawings showing the method of luminosity amendment of the picture of drawing 1 . If the luminosities of lighting generally differ to the same sample, the concentration of a picture and the differential value of a picture will change. Character recognition equipment 10 performs luminosity amendment with the relational expression shown in drawing 9 (a) in the input units 31, 32, and 33 in order to remove the influence of this lighting change. This processing saves the concentration value of a background, and the concentration value of a character line to the picture of the character used when adjusting the threshold and coupling coefficient of the middle unit of drawing 4 , and an

output unit previously, and amends the concentration value of the picture at the time of recognition, and the differential value of a picture using this value. Drawing 9 (b) is the related view showing the experimental result used as the effective reason of the luminosity amendment method by drawing 9 (a). About the same character to which the luminosity of lighting was changed, this investigates the relation between the concentration value (luminosity) of a background, and a background and the concentration value (contrast) of a character line. Since this result has both in proportionality mostly, if the relational expression of drawing 9 (a) amends the concentration of the picture at the time of recognition, and the differential value of a picture, amendment which presumed the concentration of the picture in the lighting conditions at the time of adjustment and the differential value of a picture can be performed.

[0023] When recognizing the character string which next consists of two or more characters, drawing 10 explains how to raise a recognition rate. Drawing 10 is other partial block diagrams of the character distinction section showing one example of the character recognition equipment by this invention. In addition to the base element shown in drawing 1 , in drawing 10 , the character judging section 1 of this character recognition equipment 10 is equipped with the character candidate storing section 7, the character recognition Management Department 8, and the parameter storing section 9. Moreover, into the parameter storing section 9, it has the distinction threshold storing section 91, the relative distinction threshold storing section 92, and the number storing section 93 of check columns absolutely. This character candidate storing section 7 and the parameter storing section 9 are in the program data memory 15 of drawing 2 . The character recognition Management Department 8 is realized by CPU20. When recognizing the character string which consist of a character string now, the character which can be taken for every column may be able to be limited in a part number. For example, the kinds of character which can be taken even if it becomes the same character and considers the range for several years unless a year changes if the first character (character of the 1st column) shows a year are some kinds. In this case, if the character candidate who can take for every column is specified, it stores in the character candidate storing section 7 of the character judging section 1 of the character recognition equipment 10 of the above-mentioned composition. The character recognition Management Department 8 questions the character candidate stored in the character candidate storing section 7 for every column of this, and calculates only about the output units 61, 62, and 63 corresponding to the character candidate specified there. And suppose that it is a character corresponding to the output unit which took the greatest value in the calculated output unit. Even when there are "I" and a character which was similar as shown in "1" when it does in this way for example, that only a number can be taken can distinguish the column from "1", without making a mistake, if specified. In addition, if the convention that the column the character candidate is not specified to be makes all alphabetic characters a character candidate is decided, the user

who thinks that specification of a character candidate is complicated can omit this specification.

[0024] How to have a coupling coefficient for raising the recognition rate in the case of recognizing the character string which next consists of two or more characters is explained. For example, by the part number, the character which consists of two or more character train and which can be taken for every column may be able to be limited. For this reason, what drawing 10 explained is a method which performs processing calculation of a recognition judging only about the character candidate who stores in the character candidate storing section 7 of drawing 10 the candidate of the character which the column can take for every column, and is stored. Two methods can be considered as a method of a coupling coefficient for this. One is the different threshold and different coupling coefficient for every column according to the character candidate, and one is a threshold with others common to all columns, and a coupling coefficient. The adjustment method and its effect are first explained about the method using the different threshold and different coupling coefficient for every column according to the character candidate. The kind of character to each column to be used is stored in the character candidate storing section 7 of drawing 10 . If there are few kinds of used character of each column at this time, the recognition rate of the column will improve. It comes out enough by 2-3 kinds like the column as which an used character kind expresses a year in a column, and there is also a certain column, and there is also a column for a whole sentence character. Then, the column number which adjusts in the case of adjustment of a threshold and a coupling coefficient is specified, and if it is made to adjust only about the character candidate stored by carrying out the character candidate storing section 7 refernce of the used character candidate of this column, the optimal threshold and the optimal coupling coefficient can be obtained to the column from which an used character candidate differs. As a result, a recognition rate improves, and an incorrect recognition rate can fall and can raise recognition precision sharply. Moreover, when there are few used character candidates stored in the character candidate storing section 7, for example like 1-2 kinds, the quality of printed character of a character can be inspected by investigating the value of the reliability over the character. Below, a column pair is carried out and the adjustment method and its effect are explained about all the methods using a common threshold and a common coupling coefficient. Although recognition precision improves sharply when the threshold and coupling coefficient which attained optimization for every above-mentioned column are used, you do not adjust a threshold and a coupling coefficient for every column from which an used character candidate differs, either. In this case, the character judging section 1 calculates the reliability of a whole sentence character using a common threshold and a common coupling coefficient to all columns, and it is made the object of a recognition judging of only the used character candidate stored in the character candidate storing section 7 from the result. That is, only the value of the reliability of the output unit corresponding to the used

character candidate stored in the character candidate storing section 7 is referred to, and the judgment of one character is performed. By this method, the storage capacity of a threshold and a coupling coefficient can be reduced, and it is effective in the ability to perform adjustment execution at high speed.

[0025] How to return whether character recognition was completed next is explained. It is recognized as this character recognition equipment 10 being a character corresponding to the output unit to which the inputted character took the greatest value. Since the reliability regarded as the value of an output unit being the character here is shown, even if it has taken the greatest value, when a value is small, the recognition is mistaken, and will come out and there will be a certain possibility. Then, a user sets up a distinction threshold absolutely, and when the maximum of an output unit is less than [it], he can make the result that recognition is impossible output. In order to realize this function, the absolute distinction threshold which the user specified is stored in the absolute distinction threshold storing section 91 which it had into the parameter storing section 9 of drawing 10 , after the operation of an output unit is completed, the character recognition Management Department 8 checks whether the maximum of an output unit is more than this absolute distinction threshold, and, in the case of not more than this, this character recognition equipment 10 outputs the result that recognition is impossible. Moreover, when the maximum of an output unit and the 2nd value are near, it is difficult for the character to distinguish in the character corresponding to which of the output unit of maximum and the 2nd value. For this reason, a user can make the result that recognition is impossible output, when a relative distinction threshold is set up, the maximum of an output unit has surpassed the distinction threshold absolutely and the difference of the maximum of an output unit and the 2nd value is below a relative distinction threshold. In order to make this function realize, this character recognition equipment stores the relative distinction threshold which the user specified to be the relative distinction threshold storing section 92 which it had into the parameter storing section 9 of drawing 10 . After the operation of an output unit is completed, the character recognition Management Department 8 searches for the difference of the maximum of an output unit, and the 2nd value, and it checks whether the value is more than this relative distinction threshold, and, in the case of not more than this, the result that recognition is impossible is outputted.

[0026] When recognizing the character string it is decided beforehand next that the number of characters will be, how to call sum check which decreases post-recognition is explained. Drawing 11 is explanatory drawing showing how to decrease incorrect recognition of the character distinction section 1 of the character recognition equipment 10 of drawing 10 . When the method of calling this sum check has the number which consists of seven columns like drawing 11 , it asks for the sum of seven numbers from the 1st column to the 7th column, 1 figure is printed as a check digit in an octavus column the bottom, and character recognition equipment is the method of recognizing as a number of eight columns and

collating a recognition result. Since it will be set to 28 if in the case of this drawing 11 a part number is "1234567" and it asks for this sum, 8 is printed by the octavus column and character recognition equipment is recognized as the part number "12345678." Thus, after recognizing a number, the value from the 1st column to the 7th column is added with character recognition equipment, it confirms whether 1 figure is in agreement with the value of an octavus column the bottom, and the adjustment is judged. This sum check is performed, after all recognition of each character is completed, as shown in next drawing 16 and next drawing 17 .

[0027] When the above sum checks may be performed, it may not carry out and it carries out, the number of columns used for a check is not fixed. Then, a user inputs this number of columns using a menu screen as shown in drawing 12 . Drawing 12 is explanatory drawing showing the screen which sets up the number of columns at the time of using the method of a sum check of decreasing incorrect recognition of the character differentiation section of the character recognition equipment of drawing 11 . A thing meaning is carried out and the thing whose number of columns which a user inputs here does not check "0" and for which "1" uses the last one character for a check is meant. The number of check columns specified here is stored in the number storing section 93 of check columns which it has into the parameter storing section 9 of drawing 10 , the number recognition Management Department 8 takes out here to the number of check columns, after recognition of a whole sentence character is completed, and it checks.

[0028] How to perform adjustment of the middle units 41, 42, and 43, an output unit, the threshold of 61, 62, and 63, and the coupling coefficient of the coupling-coefficient storing section 5 next using computers other than character recognition equipment 10 is explained. It may be better to do not by the main part of character recognition equipment but by the high computer of a throughput, since adjustment of this threshold and a coupling coefficient requires the processing time. Drawing 13 is the flow view showing the procedure of performing adjustment of the threshold of the middle unit of drawing 1 , and an output unit, and a coupling coefficient using computers other than character recognition equipment. On this computer, indicative datas and image data, such as the number of characters stored in the threshold previously explained by drawing 4 , the program which performs adjustment of a coupling coefficient, and the parameter storing section 9 of drawing 10 , are uploaded, or there is a program which downloads the adjustment result of a threshold and a coupling coefficient, and adjustment of a threshold and a coupling coefficient is performed by these programs. The adjustment using this alien machine uploads to a computer the instruction data and the character image data which are first stored in the parameter storing section 9 of drawing 10 from character recognition equipment 10 (Step 131). Next the instruction data and character image data are used, and a threshold and a coupling coefficient are adjusted. Since parameters, such as the number of characters and a character candidate for every column, have uploaded as instruction

data here, according to this, adjustment calculation of the optimal threshold and a coupling coefficient is performed (Step 132). Finally this adjustment result is ended by downloading to character recognition equipment 10. Since the data of two or more adjustment results can be saved as a file to a computer here, suitable recognition data can be downloaded according to a case (Step 133).

[0029] The mode of operation by which this character recognition equipment 10 is performed next is explained. Drawing 14 is the system configuration view showing an example in case the character recognition equipment 10 by this invention is used with other devices with a production line. In drawing 1 , this system is equipped with this character recognition equipment 10, a workstation 21, the loader controller 22, TV camera 23, the lighting light source 24, a work 25, a loader 26, and a monitor TV 27, and performs recognition of the part number printed on the front face of a work 25 by instructions of the recognition start from the workstation 21 connected to this character recognition equipment 10. The character for [this] recognition is a very bad character of the quality of printed character which is easy to produce a piece and a blur on a character line like the stamp character on a surface of metal, or the laser marking character on the front face of ceramic. Moreover, suppose at a part number that the marker for position logging is printed in the head and tail end.

[0030] Drawing 15 is the flow view showing the read procedure of the part number of the work 25 inside the character recognition equipment 10 of drawing 14 . The flow of reading of this part number is common even if the mode of operation of recognition is which the mode of manual recognition, semi-automatic recognition, and automatic recognition. This processing program is stored in the program data memory 15 of drawing 2 . After receiving a recognition start instruction from the external workstation 21 through the general-purpose I/O circuit 14 of drawing 2 first, the picture of the part number printed on the front face of the work 25 which is already in the visual field of TV camera 23 using the picture I/O circuit 13 is picturized, and it incorporates to an image memory 2 (Step 151). Subsequently, after detecting a marker position, the character position is detected and it recognizes for every character. A window setup is carried out, respectively and detection of this marker position is carried out to the circumference of two markers by asking for the center position of a projection distribution of the concentration in this window (Step 152). Next the position of a marker is detected and the distance between the markers of cod roe is calculated. Since the distance between this marker is known beforehand, it can judge whether the marker has detected correctly by comparing with this calculation result. That is, when this distance differs from default value greatly, it judges with a marker having not detected correctly and character recognition is interrupted. Moreover, when the position of a marker is able to detect correctly, one character is started from the relative relation between the position of a marker, and the character position. This relative relation uses thing at the time of teaching, and the relation between the pitch of a character, and the

position of a character and the position of a marker is taught at it (Step 153). Subsequently, judgment processing is performed for every started character (Step 154), and a character candidate is determined (Step 155). It judges at the last whether the whole sentence character end was carried out (Step 156), and processing will be finished if it is a whole sentence character end.

[0031] Operation in automatic-recognition mode is explained first. The loader 26 controlled by the loader controller 22 positions the work 25 with which the part number is printed so that it may enter in the visual field of TV camera 23, and it tells completion of loading to a workstation 21. The work 25 which entered in this visual field is uniformly illuminated with the lighting light source 24. Moreover, the workstation 21 which received the notice of the completion of a load orders it a recognition start to character recognition equipment 10, and the character recognition equipment 10 which received these instructions picturizes the picture for recognition by TV camera 23, and it incorporates it to an image memory 2. Subsequently, character recognition equipment 10 performs recognition of a character about the picturized picture, and transmits the result to a workstation 21. After a workstation 21 receives a recognition result, it transmits the result to the computer of a high order further, and ends one recognition. Drawing 16 is the flow view showing the sequence in the automatic-recognition mode of the character recognition equipment 10 of drawing 14 (drawing 2). the character recognition equipment 10 which character recognition equipment 10 has in the command waiting state of the recognition instructions from a workstation 21 (Step 161), and received the command signal of the recognition start from a workstation 21 when this automatic-recognition mode was chosen first (Step 160) -- recognition -- performing -- a workstation 21 -- receiving -- a recognition result -- a result -- a code -- transmitting (Step 162) . If performing a sum check at this time is specified, this check will be performed, and if mismatching is in a recognition result by the sum check, a sum check error code will be set to a result code (Step 163). It judges whether performing adjustment of the threshold and coupling coefficient which were described above using the character picture finally picturized at this time is specified (Step 164), and adjustment will be started if adjustment is specified (Step 165).

[0032] Subsequently, operation in semi-automatic recognition mode is explained. Before returning a recognition result to a high order device, when it asks a user for the check of a result or the result is mistaken in semi-automatic recognition mode, in it, a result can be corrected to the interactive mode on that spot. Since it will become complicated if a user is always asked for a check here, the reliability of recognition can ask a user for a check only at the time of a low. A user can set up this semi-automatic reliability threshold like the function 234 of next drawing 20 . Drawing 17 is the flow view showing the sequence in the semi-automatic recognition mode of the character recognition equipment 10 of drawing 14 (drawing 2). When this semi-automatic recognition mode is chosen (Step 170), it will be in the control state by the communication from a workstation 21 like previous

automatic-recognition mode, and is in the command waiting state of recognition instructions (Step 171). The character recognition equipment 10 which received the command signal of the recognition start from a workstation 21 performs recognition (Step 172). The recognition result in this semi-automatic recognition mode is displayed in the same form as the screen of a manual recognition result, as shown in drawing 18 . Drawing 18 is explanatory drawing showing the display screen of the recognition result in the semi-automatic recognition mode of the character recognition equipment 10 of drawing 14 (drawing 2). A user is asked for the check of a result before returning a recognition result to a workstation 21 at the time of a low from the semi-automatic reliability threshold specified by the reliability of the recognition result obtained here. In this case, a result will be returned if the key which has the function of transmission here is pushed when a recognition result is right. Moreover, when the recognition result is mistaken, it moves to the place of the character which has incorrect-recognized cursor using a cursor right-and-left navigation key (-><-), and out of the alphabetic character displayed on the screen lower part, cursor is moved to the place of the right character by the cursor right-and-left navigation key, and it corrects. Incorrect recognition moves to the place of the character which has incorrect-recognized the cursor of two or more characters similarly [in a certain case], and corrects a recognition result here, and if a user checks all recognition results, a code will be transmitted to a workstation 21 as a result of the recognition result (Step 173). If the sum check is specified at this time, a sum check will be performed, and if mismatching is in a recognition result by this sum check, a sum check error code will be set to a result code (Step 174). Whether performing adjustment of a threshold and a coupling coefficient using the character picture finally picturized at this time is specified judges (Step 175), and if specified, the adjustment processing will be performed (Step 176).

[0033] Subsequently, operation in manual recognition mode is explained. Drawing 19 is the flow view showing the sequence in the manual recognition mode of the character recognition equipment 10 of drawing 14 (drawing 2). Recognition execution is performed in order to judge whether it can be correctly recognized at the threshold and coupling coefficient of the middle units 41, 42, and 43 and output units 61, 62, and 63 which were adjusted by teaching before this manual recognition mode performs automatic recognition. If manual recognition mode is chosen first (Step 190), instructions of a recognition start will be performed by the operation from not the workstation 21 but the teaching box 19 (Step 191). This performs recognition (Step 192), a recognition result is displayed on the upper case of a screen, and reliability is displayed on the bottom of it (Step 193).

[0034] The automatic-recognition mode in which character recognition equipment 10 next starts recognition by the recognition instructions from the above-mentioned workstation 21, and a recognition result is transmitted to a workstation 21, The semi-automatic recognition mode for which recognition is started by the recognition instructions from a workstation 21, and a recognition result can be checked and corrected, Besides the manual recognition

mode for carrying out recognition execution by the data which carried out teaching, checking a recognition result, and judging a recognition performance The teaching mode for inputting the property of recognition objects, such as the font and window for recognition and study, and a candidate character There is utility mode in which a setup of the data transmission specification over picture evaluation, operation of IC card I/O, a workstation, etc. is performed, and it has five modes of operation. This teaching mode and utility mode are explained below.

[0035] Drawing 20 is the block diagram showing each function in the teaching mode of drawing 14 (drawing 2) character recognition equipment 10. Since arrangement and the size of a character differ from each other for every environment when using TV camera 23 of one set of a visual sensor in various environments here, it is necessary to also set up teaching data for every environment. It is the setup 210 about the character string for recognition, the font selection 220 of the character, the setup 230 of a recognition parameter, the threshold of a font, and the adjustment [TICHI / in this teaching mode 200 / adjustment] 240 of a coupling coefficient. As setup 210 to the character string for recognition, there are the setup 211 of the number of characters, setup 212 of the size of the character expressed with the number of pixels, and setup 213 of the position of the change range of a printing character train or the criteria marker for position logging first. The font of the character for recognition is specified in the next font selection 220. It is specified to be this whether it considers as the standard font 221 which character recognition equipment 10 equips with the kind of font beforehand like OCR-A, or an actual character pattern is registered. Specification of this standard font 221 registers the standard font built in beforehand as a font of the character for recognition. Moreover, specification of the object instruction font 222 performs the feature field setup 223 of a setup of the window area suitable for the judgment of the font etc., and the feature setup 224. There are the reliability threshold setup 231, the number-of-digits specification 224 of a check code, and the reliability threshold setup 234 of semi-automatic recognition as setup of the following recognition parameter. There is threshold setup 232 of the difference of reliability in this reliability threshold setup 231, and there is threshold setup 235 of the difference of reliability in the reliability threshold setup 234 of semi-automatic recognition.

[0036] The threshold of the following font and the adjustment 240 of a coupling coefficient have the adjustment execution 248 with the setup 241 of a character candidate, the character picture registration 242 of the font used for adjustment, and the authorization 243 of the parameter for adjustment. In the character picture registration 242 of a font, an outer frame is specified for every kind of character of a font, the picture is incorporated, and adjustment of a threshold and a coupling coefficient is performed to this registered font. If the picture of the marker section is incorporated, it asks for the criteria luminosity of a background and this finishes before the input of a character picture first, it will move to the incorporation of a character picture. The incorporation of this character picture specifies

the kind of character first, and, next, performs incorporation operation of a picture. Although this picture is incorporated, a raw picture is displayed and incorporation of the following character can be performed continuously. Since the character string is located in a line with the bottom of a screen, kind specification of a character is performed by moving cursor to the place of a character which it is going to specify by the right-and-left cursor key. If kind specification of this character is performed, the box in which a character outer frame is shown will be displayed in the center of a screen, and a character picture is inputted after moving this character outer frame to the position where the character is displayed with cursor. Where a character outer frame is chosen, a cursor key can perform movement of this character outer frame. The setup 244 of the least-square error for judging convergence as an adjustment parameter in the setup 243 of an adjustment parameter, Four parameters of the setup 247 of a coefficient (0 <= coefficient <=1) which the amount of corrections of the calculation result of the setup 245 of the upper limit of the number of times of an adjustment operation, the setup 246 of a coefficient (0 <= coefficient <=1) which the amount of corrections of the calculation result of adjustment exerts on the amount of corrections at present, and adjustment before one exerts on the amount of corrections at present are set up. In the adjustment execution 248, adjustment is actually performed using the data and the picture which were set up until now. It becomes the selection screen of whether it adjusts to this further by making an old adjustment result as first shown in drawing 21 into initial value, or for it to reset and to start with new initial value. Drawing 21 is explanatory drawing showing the selection screen of the initial state of the adjustment execution 248 of drawing 20 . If this selection is performed, the graph which shows an adjustment result will be displayed. The error of a performance index is expressed, the vertical axis of the graph is the maximum 1.0 of a vertical axis, and when an error is more than this, it is displayed on the place of 1.0. The horizontal axis expresses the number of times of adjustment, and the maximum turns into a value specified as the number of times of convergence by setup of an adjustment parameter. The specified convergence error is displayed in the straight line on this graph. Since adjustment is performed for every column, it is here, and a column number is inputted, adjustment is performed, and the execution result of adjustment is calculated and displayed every 10 times on this graph. Adjustment will be ended if the conditions of either the convergence error set up in the place of a setup of an adjustment parameter or the number of times of convergence are satisfied.

[0037] Drawing 22 is the block diagram showing the function in the utility mode of the character recognition equipment 10 of drawing 14 (drawing 2). This character recognition equipment 10 can use IC card 17 as external storage, and can store teaching data and image data. This utility mode 500 has the port setup 510, the I/O function 520 of an IC card, the picture evaluation 530, the data transmission function 540, and the setup 550 of character recognition equipment. The port setup 510 has the transmission-speed setup 511, the stop bit setup 512, and the parity setup 513 first. There are the function 521 which

eliminates the picture of IC card 17 with loading for the I/O function 520 of an IC card, and saves a picture to an IC card, a function 522 which carries out load elimination of the recognition data of an IC card, and saves recognition data to an IC card, and an initialization function 523 of an IC card. If each can perform these processings easily according to directions of a menu, for example, the save function 521 of a picture is chosen, they will become the menu screen which inputs the picture which a raw picture is displayed and is saved from TV camera 23. The picture which the picture was incorporated when the carriage return was inputted, as visible in the picture inputted here, and was incorporated when the IC card was inserted next and the name of image data was inputted is saved. In the multiple-value picture evaluation 531 of the next picture evaluation 530, a student's multiple-value picture is displayed for adjustment of optical system. Moreover, since the raw picture from a TV camera will be displayed if the cross-section luminance-distribution display 532 is chosen, a picture is incorporated in the place out of which the suitable picture came. Since the level line cursor which shows a cross-section position is displayed on the incorporated picture after that, if a level line cursor is moved using a vertical cursor key and the position of a cross section is specified, the brightness graph of the place will be displayed. Moreover, there is a binary picture evaluation function 533. The data transmission function 540 has the data transmission 541 of teaching data, and the transmission 542 of image data.

[0038] How to perform adjustment processing of the threshold of the middle units 41, 42, and 43 and output units 61, 62, and 63 and a coupling coefficient next while processing character recognition is explained. This is possible in the automatic-recognition mode and semi-automatic recognition mode of character recognition equipment 10. Also in any in this automatic-recognition mode and semi-automatic recognition mode, after performing the above-mentioned sum check (Step 163) of drawing 16 and the above-mentioned sum check (Step 174) of drawing 17 , it judges whether judgment (Step 164) whether this adjustment of drawing 16 is performed and adjustment of drawing 17 are performed (Step 175). This judgment is made by whether adjustment was specified during recognition as one of the setup 550 of character recognition equipment in the utility feature 500 shown in drawing 22 . this -- recognition -- inside -- adjustment -- carrying out -- if -- a character -- a quality of printed character -- changing -- as -- an object -- also receiving -- the -- change -- following -- making -- being adapted -- it can make -- moreover -- character recognition -- equipment -- ten -- having differed -- environment -- using it -- having -- a case -- having installed -- environment -- setting -- recognizing -- while -- adjustment -- carrying out -- things -- installation -- the time -- carrying out -- being complicated -- operation -- not needing -- a ** -- Drawing 23 is explanatory drawing showing the timing diagram in the case of performing adjustment of a threshold and a coupling coefficient, while the character recognition equipment 10 of drawing 14 (drawing 2) recognizes. In drawing 23 , although an adjustment operation is possible also in the period 753,754,755 which is performing

recognition of a character, since an adjustment operation requires time for it by time-sharing processing as compared with a recognition operation, the period 756,757 which performs adjustment is adjusted to the period 751,752 of loading of the work 25 for recognition, and an unload. Online adjustment is attained without this barring execution of character recognition equipment 10. Moreover, it is also possible for it to be made not to perform adjustment which used the character picture by the recognized result, either, when recognition reliability is low.

[0039] 41 of a middle unit, 42, and 43 composition are specially explained to the next. Although the above-mentioned function of a middle unit was calculating to the value which added the threshold to the output value from the input units 31, 32, and 33, and outputting the result, a reversal middle unit which outputs the value which subtracted the output value of the middle unit from the maximum which the output of a middle unit described above as a middle unit of other functions can take can be prepared. A reversal middle unit is taking out such a big output that the output value from an input unit is small to this meaning taking out such an output with the above-mentioned big middle unit that the output value from an input unit being large. This carries out effective work, when it is the feature of the character that there is anything [no] in the window area of an input unit. The output y of this reversal middle unit can be expressed with the following formula using the output y of a middle unit for which it asked by the formula (1) previously.

[0040]

$y1,n+j=1-y1,j$ (6)

Calculation of this reversal middle unit can deform like the following formula.

[0041]

$w1,k,jxy1,j+w1,k,j+nxy1,n+j = w1,k,jxy1,j+w1,k,j+nx(1-y1,j)$

$= (w1,k,j-w1,k,j+n)\,xy1,j+w1,k,j+n$ (7)

Therefore, if the threshold of output units 61, 62, and 63 is appropriately decided even if it does not prepare a reversal middle unit from this relational expression, the function same with having prepared the reversal middle unit, as shown in the following formula (8) is realizable.

[0042]

[Equation 2]

数　2

$$Z2,k=\sum_{j-1}^{n}[(w1,k,j-w1,k,j+n)\times y1,j+w1,k,j+n] \qquad (8)$$

[0043] Compared with the case where a reversal middle unit is prepared, the number of middle units is half, the operation of this of character recognition decreases so much, and it becomes high-speed. However, since having adjusted the coupling coefficient in the state

where there is a reversal middle unit tends to calculate the threshold of this output unit, its method of preparing a reversal middle unit at the time of adjustment, and removing a reversal middle unit at the time of character recognition is effective.

[0044] the time -- **** -- the sample character picture for adjusting the threshold and coupling coefficient of a middle unit and an output unit is explained It means that this sample character picture had carried out adjustment which can respond to cases more nearly various as many. However, a man day is required for collecting various kinds of character pictures as a sample. Then, if the position gap range of a character and the change range of a luminosity are specified to one character picture and the picture in which the picture which produced the position gap from the sample picture, and the luminosity were changed will be generated automatically, adjustment using various kinds of sample pictures can be performed, without seldom applying a man day. Drawing 24 (a) and (b) are explanatory drawings showing how to generate automatically the picture in which the picture in which the character recognition equipment 10 of drawing 14 (drawing 2) produced the position gap from the sample picture, and the luminosity were changed. Automatic generation of the picture in which the position was changed as shown in drawing 24 (a) is realizable by shifting O[from zero O] ' in the range specified as a change range, if there is a sample picture of a basis. if for example, the change range is specified to be 3 pixels of plus or minus -- zero O of a sample picture -- X and the direction of Y -- +3, +2, and + -- if 1, 0, -1, -2, and 49 kinds of pictures shifted -three are used, a sample picture with a position gap can be acquired If the change range of the luminosity from the sample picture of a basis is specified as similarly shown in drawing 24 (b), when only the range generates the picture to which concentration was changed, the sample picture of contrast with luminosity change can be acquired.

[0045] The example of the method of other image processings [kind / of image processing in an input unit] is explained below. The image processings performed in the input units 31, 32, and 33 explained by above-mentioned drawing 3 were the differential from the upper part to a horizontal character line, the differential from the lower part to a horizontal character line, the differential from the left to a vertical character line, the differential from the method of the right to a vertical character line, and five kinds of concentration sum totals. This differential processing is a method which adds the differential value perpendicularly to the character line, as drawing 3 explained, and the concentration sum total is a method which calculates the average of the concentration in a window. The method of this image processing is effective to the bad character of contrast like the laser printing character on the front face of ceramic. Four kinds of image-processing kinds in which this character recognition equipment 10 detects an edge in quest of a differential value to the shade picture in a window by primary differential other than five kinds of this image processing, Four kinds of image-processing kinds which detect an edge in quest of a differential value to the shade picture in a window by secondary differential, It has 12

kinds of two kinds of image-processing kinds which make the inside of a window binary and count the area of the white field (or black field) in the window, and two kinds of image-processing kinds which make the inside of a window binary and detect an edge to a binary picture. 12 kinds of this image processing is explained in order below.

[0046] The method which detects an edge by primary differential or secondary differential to a shade picture first is explained using drawing 25 . Drawing 25 (a), (b), and (c) are explanatory drawings of the edge-detection method by the primary differential and secondary differential from a left in the image processing in a window. Drawing 25 (a) is the example of the window cut on the lengthwise character line, and a slash portion expresses a character line in this drawing. Drawing 25 (b) expresses the primary differential value about a line which * mark of the x directions of [when differentiating the 1st order from a left] attached in the x directions in this window now, and drawing 25 (c) expresses the secondary differential value from the left to the x directions of in a window about the line which * mark similarly attached. Primary differential is explained first. As shown in drawing 25 (b), the primary differential value in a window is calculated for every Rhine of all. And in quest of the maximum of the primary differential value of each of that line, total of the differential value is calculated about all lines, and the average of the maximum of the primary differential value which carried out the division of the total value with the number of lines of the window is calculated, and let this value be the output value of an input unit. Secondary differential is explained below. As shown in drawing 25 (c), the secondary differential value in a window is calculated for every Rhine of all. And in quest of the maximum of the secondary differential value of each of that line, total of the differential value is calculated about all lines like primary differential, and the average of the maximum of the secondary differential value which carried out the division of the total value with the number of lines of the window is calculated, and let this value be the output value of the input units 31, 32, and 33. Thus, the output value of the input unit independent of the size of a window can be obtained by normalizing the result of an image processing in the size of a window.

[0047] The method which next makes the inside of a window binary and counts the area of the black field in the window is explained. A use is restricted when the binary picture in which contrast was comparatively stabilized well by the method of the image processing in this window is acquired. The number of pixels corresponding to black is counted in the window which made the inside of a window binary and next made it binary first. The division of the counted number of black pixels is carried out in the area of a window, and it considers as the output value of the input units 31, 32, and 33. even if the pixel counted here counts not a black pixel but a white pixel -- reversal unit all ** -- it is equivalent When what is necessary is just to use the binary-ized threshold determined with algorithms, such as for example, a fixed binary-ized threshold, the p tile method, and a discriminant analysis method, and the binary picture by which the contrast of the target character was stabilized

well is acquired, the method of making the result which calculated to the luminosity with reference to the luminosity of for example, a character background a binary-ized threshold of the threshold of binary-izing is also effective. How to make 85% of the luminosity of a character background a binary-ized threshold as an example etc. can be considered.

[0048] The method which next makes the inside of a window binary and detects an edge to a binary picture is explained. A use is restricted when the binary picture in which contrast was comparatively stabilized well by the method of the image processing in this window is acquired. First, the inside of a window is made binary and the place which changes to black from white about each line in the window made binary is detected as an edge. A line here is the same definition as the line of the place of the primary differential to the shade picture explained in drawing 25 , and secondary differential, and is a perpendicular direction to the direction of a character line. If an edge is detected with the line, the edge-detection method with the same said of the following line will be applied, and it detects about all the lines in a window. And when processing of all lines is completed, the number of lines which detected the edge in the window is calculated, this is normalized in the size of a window, and it considers as the output value of the input units 31, 32, and 33.

[0049] The special middle unit 44 which next combined two or more windows is explained. The above-mentioned middle units were the middle unit which calculates to the value which added the threshold to the output value from the input units 31, 32, and 33, and outputs the result of an operation, and a middle unit which outputs the reversed result. The input values of these middle units are the size of the differential value in a window, and the average of a luminosity. For this reason, when the thickness of printing is changed, unlike the time of changing a luminosity, the size of a differential value and the average of a luminosity are changed sharply, and a feature extraction cannot be performed correctly. In order to solve this problem, the combination middle unit 44 which makes an input value the relative value of the output value of the input units 31, 32, 33, and 34 as others and a middle unit combining two or more input units was formed. This combination middle unit is explained using drawing 26 . Drawing 26 is explanatory drawing showing an example of the combination middle unit which is a special middle unit of the character recognition equipment 10 of drawing 14 (drawing 2). The middle unit 44 of drawing 26 is taken as the input combining the output value of the input units 32 and 34 of the input unit group 3. First, each above-mentioned input units 31, 32, 33, and 34 perform an image processing in a window in the image-processing section 312,322,332,342 based on the window position data stored in the window position storing section 311,321,331,341, and make the image-processing result the output value of an input unit. The middle unit 44 is taken as the input combining the output value of the input units 32 and 34 of the input unit group 3. In this case, if the output value of the input units 32 and 34 is inputted into the middle unit 44, the operation part 442 of the middle unit 44 will calculate to the value which added the threshold stored in this difference in quest of the difference of the output value of two input

units at the threshold storing section 441, and will be taken as the output value of the middle unit 44. The combination of an input unit may use the output value of not only when using the difference of two input unit output values in this way, but three input units or more. If this is explained taking the case of the case where three input units are used, the average of the output value of two input units will be calculated first, and it will consider as the input value of the middle unit 44 in quest of the difference of this average and another input unit. The operation which searches for this adjustment computation and difference is performed in the middle unit operation part 442, calculates to the value which added the threshold stored in the threshold storing section 441, and let it be the output value of the middle unit 44. Mixture with the usual unit is also possible for this combination unit, and the input unit inputted into the usual middle unit can also be used for a combination unit.

[0050] Drawing 27 is used and explained about a setup and change of the combination of this input unit below. Drawing 27 is a menu screen about a setup and change of an input unit to the above-mentioned combination middle unit. The number of the middle unit which sets up combination first is inputted. Drawing 27 is an example which has inputted "1." The number of input units of the 1st term which next performs combination is inputted, and, next, the number of an input unit (window) is inputted. The number of input units is inputted also about the 2nd term, and the number of an input unit is inputted. When an input unit is plurality, it divides and inputs with a comma. And finally, a setup of combination inputs by the number whether it is deletion, and a setup is performed and it makes a change. The value of the 1st term set up here and the 2nd term is inputted into a middle unit. The operation currently performed by the middle unit operation part 442 next is explained. Calculation by the operation part of this combination middle unit is performed according to an image-processing kind as follows.

[0051] When an image-processing kind is differential processing, 1) Middle unit input-value = A (1st Combination [term / 2nd] Term of lot doubling) + threshold 2 image-processing kind In concentration sum total processing, middle unit input-value = If the input value of the middle unit calculated by the middle unit input-value =(2nd term of 1st term lot [of combination] doubling)+ threshold above 1-3 is computed when a 2nd term [of the (Combination / term / 2nd] 1st term of lot doubling) / combination / + threshold 3 image-processing kind is binary-ized processing, the remaining processing previously It is completely the same as that of the described middle unit, and the reversal middle unit to this middle unit can also be constituted. That is, it is also possible for the operations which perform this combination middle unit by middle unit operation part to only differ, and for others to combine, to have the feature that it can treat completely similarly to the old middle unit which is not a middle unit, and to use simultaneously with the middle unit which is not a combination middle unit. In addition, the combination of the optimal input unit is determined as the problem whether it should combine, the determining method, i.e., which input unit, of combination of an input unit, using technique, such as the technique of

principal component analysis, and a variable sorting by selection, in the conventional multivariate analysis.

[0052] Other adjustment methods of a threshold and a coupling coefficient are explained below. Although a threshold and a coupling coefficient also have the method of adjusting in **** as drawing 4 explained, it can ask using a multiple-regression model. According to this method, a coupling coefficient is easily calculable. When this multiple-regression model sets y1, j, and a coupling coefficient to w'1, and k and j for the output value of a middle unit, o2 and k can express the output value of an output unit like the following formula.

[0053]

[Equation 3]

数 3

$$o2,\ k=\sum_{j=1}^{2n} w'1,\ k,\ j\times y1,\ k \qquad (9)$$

[0054] That is, in order to recognize a certain picture, the output values y1 and j of a middle unit are calculable first. As opposed to o2 and k which are equivalent to the output value of an output unit at this time to the correct answer of the character of the picture, "1" and except it as "0" When it thinks to all character kinds, it turns out that coupling-coefficient w' can calculate easily by the thing with the number equal to the number of an output unit of variable w' expressed with the subscript k in the formula expressed with a formula (9), and formulas for which simultaneous equations are solved. What is necessary is just to make this into a middle unit threshold in quest of the statistical average about the picture inputted about the threshold of a middle unit. In order that a recognition performance may raise recognition precision further although it comes out to some extent even if it uses the threshold and coupling coefficient for which it asked by the above-mentioned method, you may perform adjustment processing explained by drawing 4 by making this into initial value.

[0055] This character recognition equipment 10 can perform setup of the above-mentioned window, specification of the image-processing kind in a window, etc. using a workstation by transmitting data by the communication line. Then, a setup of the window mentioned above, specification of the image-processing kind in a window, etc. are explained using drawing 28 - drawing 29 about an example when using an alien machine like a workstation. Drawing 28 is a screen showing the processing menu of the workstation linked to the character recognition equipment 10 of drawing 14 (drawing 2). Thus, it has data transmission, an adjustment parameter setup, a character parameter setup, adjustment execution, window evaluation, a window setup, a coupling-coefficient data setup, character kind change, statistical analysis, and the function of an end in a workstation. Drawing 29 is the block diagram showing an example of the function of the workstation linked to the character

recognition equipment 10 of drawing 14 (drawing 2). There are data transmission 2910, the adjustment parameter setup 2920, the character parameter setup 2930, the adjustment execution 2940, the window evaluation 2950, the window setup 2960, the coupling-coefficient data setup 2970, the character kind change 2980, and statistical analysis 2990 in the function 2900 of this workstation. This function is equivalent to ten functions of drawing 28 . A processing number is chosen with the processing menu corresponding to each function as showed each function of drawing 29 similarly to drawing 28 .

[0056] Data transmission 2910 has the instruction data transmission 2911, such as a threshold and a coupling coefficient, and the image data transmission 2912 first. By the adjustment parameter setup 2920, the value of the constants Bk and Ck of the formula (4) of above-mentioned adjustment and (5) is first set up by the parameter setup 2921, respectively. Moreover, a binary-ized threshold is set up in the binary-ized threshold setup 2922. In the character parameter setup 2930, the number of character rows in instruction data, the number of characters for every line, the length of a character and horizontal size, the length of a character and a horizontal pitch, and the used character candidate for every column can be changed or set up. The part number which should be first recognized by the number setup 2931 of character rows consists of matrices, or the line count is set up, and the number of characters of each line is set up in the number setup 2932 of characters. By the character-pitch setup 2934, in the character-size setup 2933, the length of the character of the character for recognition and horizontal size are set up per pixel, and the pitch of the longitudinal direction of a character is set up per pixel, and by the character-pitch setup 2934, when a character string is two or more lines, a vertical pitch, i.e., the pitch of the line, is set up per pixel. Moreover, in the character candidate setup 2935, the used character candidate to each column is set up for every column. In the adjustment execution 2940, adjustment of a threshold and a coupling coefficient which were explained by drawing 13 is performed. The adjustment execution 2940 has the two modes, the adjustment calculation 2941 and a multiple regression analysis 2942, the adjustment calculation 2941 is a method using an above-mentioned formula (4) and (5), and a multiple regression analysis 2942 is the method of using a formula (9). In the adjustment calculation 2941, it specifies first the calculation about which column it is, and, next, moves to execution. Specification of a column uses the character candidate, when the used character candidate is decided for every column like a part number. As mentioned above, a setup and change are possible for this character candidate at the character candidate setup 2935. The display which took the history after starting the display which took the newest value of the reliability for every character to all characters along the vertical axis in execution of adjustment calculation, and made the horizontal axis the character kind, the value of the reliability of the character immediately after calculating, and calculation along the vertical axis, and made the horizontal axis the character kind, and the continuous display which took the value of the

square error sum along the vertical axis, and took the number of times of adjustment calculation along the horizontal axis perform. In the window evaluation 2950, there are the window input-value evaluation 2951, the input unit combination evaluation 2952, the font pattern evaluation 2953, window position evaluation 2954, and all window input-value evaluations 2955. In the window input-value evaluation 2951, the position of a window and the kind of an image processing called differential, the above-mentioned concentration sum total, and above-mentioned binary-izing are specified, and the value of the window of all characters is displayed on a horizontal axis as a character kind for a vertical axis. Since a window is a square fundamentally, the method of the input of a window position inputs three points, x of the upper left, a y-coordinate, x of the lower left and a y-coordinate, and x of the lower right and a y-coordinate. The combination evaluation 2952 of an input unit estimates the middle unit which combined the above-mentioned input unit. The number of the input unit (window) combined first is inputted, and a character kind and a vertical axis are displayed [the output value of the middle unit at that time] for a horizontal axis as an output value of a middle unit about a whole sentence character. In the font pattern evaluation 2953, a character kind and a vertical axis are displayed [the output value of the middle unit to the position and image-processing kind of window which have been set up] for a horizontal axis as an output value of an input unit to a whole sentence character. At this time, binary-ized processing or shade processing is inputted first, next a character is specified, the number of a middle unit to carry out the enlarged display of this character, display the position of a window, and display on the next is specified, and the output value of a middle unit is displayed. The window position evaluation 2954 is used in order to check the position of the window to a letter face, and if the number of a window is inputted first, it will display the position of the window to a letter face. All window evaluations 2955 input the kind of character, and the number of a window is displayed for a horizontal axis and they display the output value of each input unit for a vertical axis as an output value of an input unit. In the window setup 2960, there are two items, the window setup 2961 and the input unit combination setup 2962. In the window setup 2961, that used flag which does not require whether this window is used, the kind of image processing explained by the above to a window, and the position coordinate of a window are inputted and set up. The setting method of the position of a window is the same as that of the window evaluation 2950. In the input unit combination setup 2962, it is the same as the menu of drawing 27 , and selection with specification of the number of the middle unit using combination and specification of whether to delete with specification of whether combination sets up or changes and specification of the number of the input unit to combine are performed. By the coupling-coefficient data setup 2970, it has the data setup 2971, the data clearance 2972, the data copy 2973, a data compression 2974, and the function of automatic setting 2975 by the function for carrying out the care force of the initial value of the coupling coefficient between a middle unit and an output unit. In the data setup 2971, the number of an output

unit is first specified by the function to use by the case where it changes when setting up the initial value of the coupling coefficient to a specific output unit, and a value to set it as the next is inputted. The data clearance 2972 is the function which sets all the coupling coefficients to a specific middle unit to 0, and is an example. **** -- when a new middle unit is extended, it uses Here, the number of a middle unit to clear first is specified. By the data copy 2973, a threshold and a coupling coefficient are copied between columns. The number of a column to specify and copy the number of a column with the threshold and coupling coefficient to copy is specified and copied. In a data compression 2974, a division is carried out with the value which specified the coupling coefficient between a middle unit and an output unit, and the value of a coupling coefficient is made into a value small on the whole. This is used, when a value becomes large too much and produces overflow. Automatic setting 2975 is the function to determine a threshold and the initial value of a coupling coefficient. The value of the middle unit is calculated using a suitable character picture, from the output value of the middle unit, when output values are 0-0.4, initial value of a coupling coefficient is set to -1, initial value of a coupling coefficient is set to 0 at the time of 0.4-0.6, and initial value is determined like +1 at the time of 0.6-1.0. In the character kind change 2980, it uses in order to generate teacher data in the adjustment calculation 2941 by the function for changing or correcting the picture of a character, and correspondence of a character kind. Moreover, when there is a character picture of inferior quality and this picture is taken into adjustment calculation, degradation of a recognition performance may be caused. In this case, it is better to fly this picture and not to use it for adjustment calculation. By specifying it as the kind of character which is not used from the character kind change 2980 to this picture at this time, adjustment calculation is not performed and degradation of an overall recognition performance does not take place, either. In statistical analysis 2990, combination with the optimal window (input unit) is determined by the method called variable sorting by selection. It chooses which input unit this should just combine by the method which calculates all the combination of an input unit and is called variable sorting by selection. First, the criteria of this selection are inputted, it is the function which outputs the combination which can secure the recognition performance which these criteria express, and adjustment calculation of the adjustment execution 2940 can be performed from this combination. This operation loads instruction data by the instruction data transmission 2911 in data transmission 2910 first, loads the image data used for adjustment or evaluation by the image data transmission 2912, and practices each function.

[0057] Other composition of a workstation 21 and character recognition equipment 10 is explained below. Drawing 30 is drawing having shown an example of functional block of a workstation 21 and character recognition equipment 10. The design module 3000 is carried in a workstation 21, and this design module 3000 consists of the recognition model generator 3001, the adjustment monitor 3002, a recognition simulator 3003, the recognition

parameter storing section 3004, and the sample picture storing section 3005. The recognition module 3006 is carried in character recognition equipment 10, and it consists of a recognition monitor 3007, a recognition module 3008, and the parameter storing section 3009. The recognition model generator 3001 is related with a user for recognition. A question is taken out, recognition models, such as a kind of image processing in an input unit and combination of a middle unit, are generated from the knowledge about the reply and the pattern recognition to build in, and a recognition parameter is generated. The adjustment monitor 3002 sets to the data area of the recognition simulator 3003 this parameter and the sample picture beforehand uploaded from character recognition equipment 10, and starts the recognition simulator 3003. Whenever the recognition simulator 3003 is equivalent to the recognition module 3008 carried in character recognition equipment 10 and it performs recognition processing, a result is returned to the adjustment calculation monitor 3002. The adjustment calculation monitor 3002 corrects a recognition parameter based on a recognition result, and it repeats adjustment calculation until a predetermined recognition performance is obtained. If adjustment calculation is completed, the calculated recognition parameter is transmitted to the recognition parameter storing section 3009, and it comes to be able to perform recognition execution. This design module 3000 is described by expert system construction shell, and is performed by workstation.

[0058] The recognition model generator 3001 will generate the initial value of a recognition parameter using the knowledge built in while taking out a question to a user, if a user specifies the kind and the feature for recognition. It is the kind of the portion which is likely to serve as the feature besides the target object pattern as a thing specified by a user, and image processing suitable for the feature extraction of the range etc. About this user specification item, it has the utility for making a judgment of a user easy. In order to determine the kind of image processing explained in drawing 29 as this example, image processings, such as differential, are performed, a result is displayed or there are some which determine initial value with multivariate analysis.

[0059] The adjustment calculation monitor 3002 receives the directions about the adjustment calculation execution from a user, and it manages the recognition simulator 3003 so that the suitable result for a short time may be obtained. The know-how according to the property of a recognition pattern is in the method of adjustment calculation, and the study monitor 3002 is equipped with this knowledge. First, temperature, the end conditions of calculation, etc. required for calculation set up an adjustment parameter, or the main functions of the adjustment calculation monitor 3002 output them in the form where it is easy to understand a result to a user.

[0060] Moreover, the picture united with the position gap explained, for example in drawing 24 , luminosity change, and actual recognition environment, such as configuration deformation, from the picture stored in the sample picture storing section 3005 is generated.

Furthermore, since machine time is sharply shortened by the scheduling of calculation, the adjustment monitor 3002 obtains as quickly as possible the recognition parameter which is mistaken and distinguishes a pattern that there is nothing using the knowledge about the scheduling of such calculation for the increase in efficiency of calculation.

[0061] The pattern recognition module 3009 is structure as shown in drawing 1 . The pattern recognition monitor 3007 changes a distinction function into the optimal state according to the candidate for recognition by setting up a recognition parameter to a recognition object pattern. This function is effective especially in many [when the appearing candidate of a pattern can limit to a specific kind corresponding to an appearance place] industrial use character / pattern recognition. For example, if the recognition parameter which distinguishes only the candidate character specified that drawing 10 explained to the digit for every digit like a part number is used, a recognition rate will become [rather than] high using the recognition parameter which distinguishes all alphabetic characters. The recognition parameter storing section 3008 transmits the parameter of the recognition parameter storing section 3004 of the design module on a workstation by data transmission, and stores it. If the character for recognition changes, it will ask for the recognition parameter according to the object in the design module 3000, and it can respond easily by changing the data of this recognition parameter storing section 3008.

[0062]

[Effect of the Invention] According to this invention, the printing state of a thing or a character where the quality of printed character of a character and the font of a character are changed is bad, for example, it is effective in the recognition stabilized by the object which the piece of the bad picture of contrast or a character line and a thing called a blur produced being realizable.